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The distribution and status of Sage Skipper *Muschampia proto* (Ochsenheimer, 1808) (Lepidoptera, Hesperiidae) at the limit of its range in the north-western Balkans

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Abstract. We analysed the status and distribution of the Sage Skipper *Muschampia proto* (Ochsenheimer, 1808), a rather rare and local Hesperiidae species at the edge of its range in the north-western part of the Balkan peninsula, mainly Croatia and Bosnia & Herzegovina. In order to determine the species' presence in the region, we mapped the occurrence of its hostplant, Jerusalem Sage *Phlomis fruticosa* Linnaeus (Lamiaceae). We also summarized all the available knowledge on *M. proto* in the Balkan Peninsula and provided a literature overview for each country this species has been recorded in so far. In Croatia, the distribution of *M. proto* is very limited and is located only in the wider surroundings of Dubrovnik city. In the present paper, we also provide the first and only record of *M. proto* in Bosnia & Herzegovina, from a single locality close to the Croatian border in the Dubrovnik area. Due to its limited distribution in both countries, we propose that the conservation status of the species should be changed from none to vulnerable.

Introduction

The genus *Muschampia* Tutt, 1906 is represented in Europe by three species; Spinose Skipper *Muschampia cribrellum* (Eversmann, 1841) and Tessellated Skipper *Muschampia tessellum* (Hübner, 1803), both confined mostly to eastern Europe, and Sage Skipper *Muschampia proto* (Ochsenheimer, 1808) sporadically distributed across southern and eastern Europe (Tolman and Lewington 2008).

In general, the distribution of *M. proto* ranges from Maghreb and the Iberian Peninsula, across southern and eastern Europe to parts of European Russia and Iran (Tshikolovets 2011). It is an easily recognisable species, with dark olive grey ground colour of the wings with yellow shades and white marks (Pamperis 2009). Despite being present in large parts of southern Europe, it is a quite local species with abundant populations in some areas (Leraut 2016). It inhabits dry grasslands in the hilly and submontane areas up to 1600 m above sea level (D'Alessandro et al. 2008; Leraut 2016). The caterpillars feed on the genus *Phlomis* including the Jerusalem Sage *Phlomis fruticosa* Linnaeus (Lamiaceae) (Leraut 2016).

Phlomis fruticosa is semi-deciduous Mediterranean shrub with large yellow flowers. It is widespread in the northern part of the Mediterranean region from Italy to Cyprus. In particular, it occurs in southern Italy (Apulia and Sicily), it is very common in Albania and Greece, and it is present

further east along the coasts of southern Anatolia as far as Cyprus. Shrublands dominated by this species are a striking physiognomic feature of calcareous hills in the central Mediterranean region, in particular in Albania and Greece. This vegetation can be found in heavily grazed landscapes and in abandoned fields and its formation is related to the long history of exploitation of the Mediterranean region by human civilisations (Fanelli et al. 2015).

According to the Red List of Vascular Flora of Croatia, the species is near threatened (NT) (Nikolić and Topić 2005) and is sporadically distributed in the coastal zone of Dalmatia and on some islands including the Cres Island in the northern Adriatic (Nikolić 2004).

In Bosnia & Herzegovina, *P. fruticosa* is sporadically distributed only on a narrow area near the border in Croatia, SW of Popovo polje. This area is located in the municipality of Ravno, and as far as it is known extends from the village of Uskoplje to the village of Zavala (Đorđije Milanović, pers. comm.).

The goal of this paper is to present the current knowledge about the distribution and conservation status of *M. proto* in the north-western part of Balkan peninsula, mainly Croatia and Bosnia & Herzegovina with an overview of its occurrence in other countries on the peninsula.

Materials and methods

In order to gain an overview of the historical occurrence of *M. proto* in Croatia and neighbouring countries, a systematic analysis of the published literature was conducted. For some countries like Bosnia & Herzegovina (Lelo 2016), Serbia (Popović and Verovnik 2018), Montenegro (Franeta 2018), and Albania (Cuvelier et al. 2018) recent checklists have been published and were used as a main source for the species' occurrence and/or distribution. For Northern Macedonia, Bulgaria, and Romania, available reference papers were used to assess the species' status, while for Greece the main source of information was found in the book Butterflies of Greece (Pamperis 2009).

Between 2017 and 2019, more than 30 days were spent in the field in southern Croatia and Bosnia & Herzegovina in order to assess the present status and distribution of butterflies in the region, including *M. proto*. As *P. fructosa* had previously been recognised as the hostplant of *M. proto* in Croatia (Lorković 2009), we also mapped the occurrence of this species in the study region.

In several localities where the adults were observed in larger numbers we also searched for the caterpillars of the species during our survey. However we were not successful in recording any. This proved to be a good method in other countries like Albania where in a recent survey the presence of *M. proto* species was confirmed in six localities based on larval records (Micevski et al. 2015). Thus all the records provided in this work are based on adult butterflies only.

Abbreviations of observers

DD = Dubravko Dender; MM = Matea Martinović; TK = Toni Koren.

Results

Altogether, we were able to record *M. proto* in five localities of which one lies in Bosnia & Herzegovina. All the localities are situated in the surroundings of Dubrovnik. The list of the localities containing the relevant toponyms, a short description of the habitat, altitude, coordinates, dates of visits and observers are presented below. Localities are arranged in geographical order from west to east (Fig. 1). All elevations are expressed in metres above the sea level.

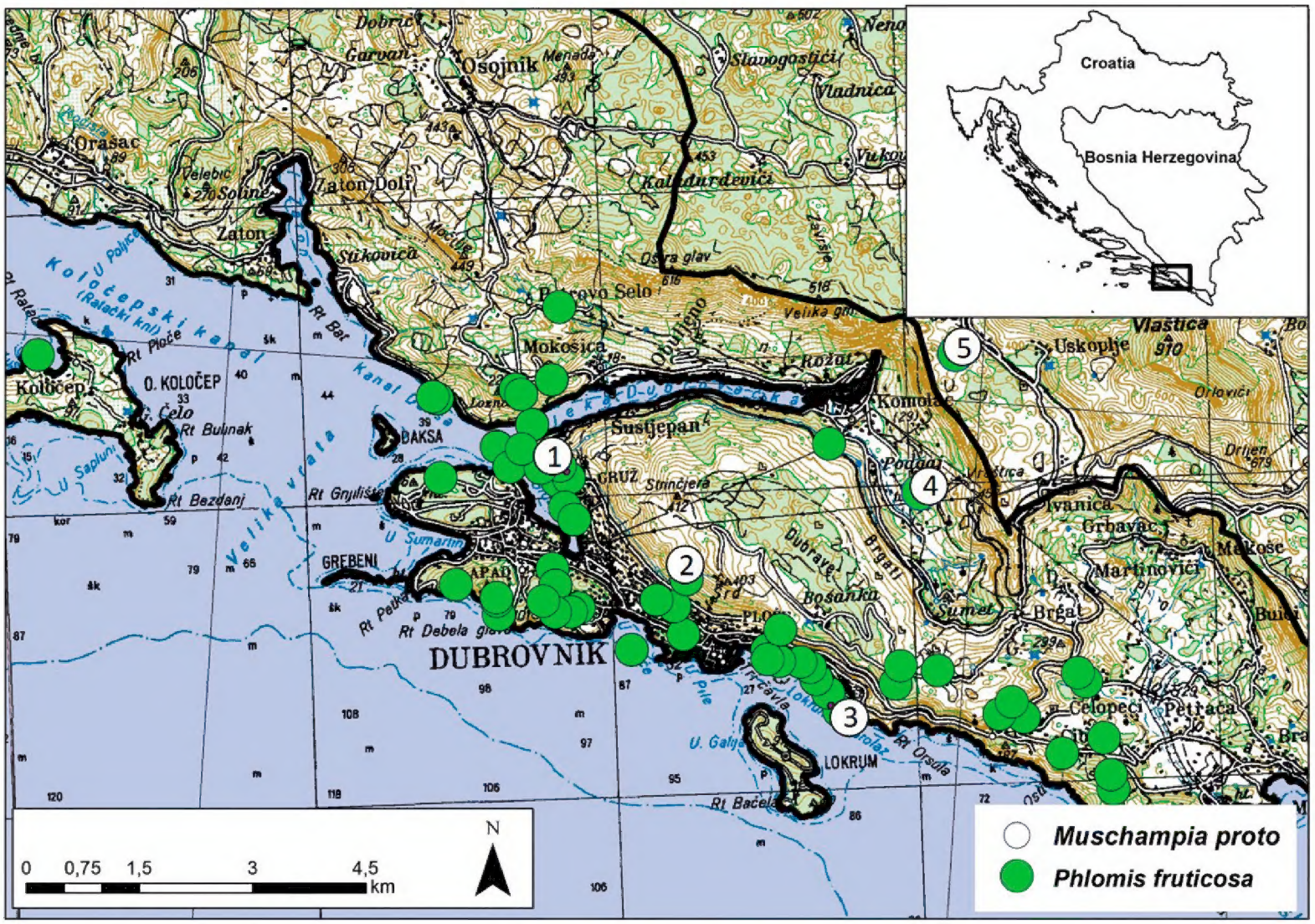

Figure 1. Distribution of *Muschampia proto* and its host plant, *Phlomis fructosa* in southern Croatia and Bosnia & Herzegovina. Numbers correspond to the ones given in Materials and methods section.

Croatia

1. Dubrovnik, Nuncijata, ruderal area bordering karst slopes; 42,664303N, 18,088589E, 148 m a.s.l.; 29.iv.2018. (DD, MM, TK), 13.x.2018. (DD), 3.vii.2019. (DD), 1.viii.2019. (MM)
2. Dubrovnik, Mt. Srđ plato, karst grasslands in the vicinity of the fort Imperial, 42,650571N, 18,109717E, 340 m a.s.l.; 29.ix.2018. (DD, MM, TK)
3. Dubrovnik, Orsula, garrigues, 42,633851N, 18,132406E; 77 m a.s.l.; 3.x.2018. (DD), 27.viii.2019. (MM)
4. Dubrovnik, Šumet, near Golubov kamen, old railroad path at karst slopes; 42,658883N, 18,148278E; 185 m a.s.l.; 18.vii.2017. (TK), 1.vii.2018. (TK), 29.ix.2018. (DD, MM, TK)

Bosnia & Herzegovina

5. Ravno, Uskoplje, ruderal area of the former railroad station bordering karst slopes 42,676026N, 18,155403E; 334 m a.s.l.; 2.viii.2019. (MM)

While the presence of *M. proto* in Croatia has been known for more than a century (Mann 1869), no overview of the status and distribution of the species in the country was ever presented. The first record of *M. proto* in the territory of Croatia originates from Mann (1869) who recorded it in Ragusa (Dubrovnik). Later, Abafy-Aigner (1902) cites it again for Dubrovnik, Galvagni (1909) mentions it from Gravosa (Gruž) and Lapad, both parts of Dubrovnik city. Zerny (1920) and Schwingenschuss

Figure 2. Habitat of *Muschampia proto* in Uskoplje, Bosnia & Herzegovina. Photo by Matea Martinović.

and Wagner (1925–1927) mention it for Gravosa (Gruž). Gušić (1916) mentions the records of Taborski Dragutin from Dubrovnik, while the same material is mentioned by Mladinov (1975) from Dubrovnik and Lapad, collected by Gušić and Taborski. Lorković (2009) mentions in his manuscript written in 1954 that the species is present on Srđ above Dubrovnik and it is very common in July and August. Since then, no new observations of this species were published. Stauder (1923), in his overview of the Lepidoptera of the Adriatic coastline, mentions it for Ragusa, Gravosa and Lapad. In retrospective, only records in Dubrovnik city or in near vicinity exist in the literature.

During our surveys, we recorded this species in four localities in Croatia, two of them in the near suburbs of Dubrovnik city, one locality on Mt. Srđ, and one locality above Ombla river. Its hostplant, *P. fruticosa*, was recorded in about 60 localities, mostly from Dubrovnik and its near surroundings. Single plants were observed on Koločep Island and on the karst plateau Lisačke Rudine above Doli village about 25 km from Dubrovnik.

The distribution of *P. fruticosa* is discontinuous in the area of Dubrovnik and its surroundings, and it occurs almost exclusively near different routes, be it roads, macadam, or footpaths. In such habitats, it also enters the marginal parts of forests. In some areas it can be present in a wider belt around the roads, like in the area of Orsula where it is a part of the garrigues along with common myrtle *Myrtus communis* Linnaeus, mastic *Pistacia lentiscus* Linnaeus, hairy thorny broom *Calicotome infesta* (C. Presl) Guss, and other plants. Given the locality of the findings and their localisation, we believe that human activity plays a significant role in its distribution.

In Bosnia & Herzegovina we recorded the hostplant *P. fruticosa* in the middle of October of 2018 in a single location. The entire area of a former railroad station, today in ruins, is completely covered

with Jerusalem Sage which is also spreading on the karst slopes above. (Fig 2) After several visits to the described locality in 2019 we finally managed to record *M. proto* in the beginning of August.

Discussion

In order to help with the future treatment of this species in the Balkans, we present the current knowledge and status in each of the Balkan countries. We are aware that the literature regarding butterflies of the Balkan states is very immense and it is possible that we did not cover all of the literature for the countries mentioned.

Montenegro

The occurrence of *M. proto* in Montenegro has been known for almost a century. It was first recorded by Rebel and Zerny (1931) in Rijeka. Later records: Carnelutti and Michieli (1958), Kühnert (1971), Müting (1974). Sijarić and Mihljević (1972) recorded it near Sutomore and reported it as common. Sijarić (1984) mentions it for the coastal zone of Montenegro without any exact localities. The closest findings of this species in Montenegro are from Mt. Orjen, approximately 30–35 km from the localities in Croatia (Franeta 2018).

Serbia and Kosovo

Only a single record of this species for Serbia and Kosovo exists (Jakšić 1988, 2003), however is has since been attributed to the village of Vratnica, which is situated in the Republic of Macedonia (Popović and Verovnik 2018). Due to the lack of suitable habitats for this species even on the Serbian side of the Border with Northern Macedonia, the species is at present not included in the checklist of butterflies of Serbia which includes Kosovo (Popović and Verovnik 2018).

Northern Macedonia

Limited information is available about the status of this species in Northern Macedonia. According to Krpač and Darcemont (2012) it is present in the country, but its conservation status in the Red list is not accessed. So far, the only record available to us is from village of Vratnica (Jakšić 1988, 2003).

Albania

Beshkov (1995) was the first to record *M. proto* in Albania in Himara and Muzina. Later, Šašić et al. (2015) found it in a single locality while Micevski et al. (2015) in six additional localities. It seems that the species is widespread but rather local in the country.

Greece

In Greece, *M. proto* seems to be fairly abundant and has the widest distribution in the Balkan peninsula. It is present throughout the mainland and Peloponnesus (Sotiris 2014; Pamperis 2009). In also occurs on many islands including but not limited to Ithaki (Weidlich 2016), Kárpathos (Cuvelier and Mølgaard 2012), Kastellórizo (Cuvelier and Mølgaard 2012), Kefalonia (Weidlich 2016), Kythira (Rebel 1937; Sotiris 2014), Korfu (Baldock and Bretherton 1981; Embacher 2000; Pamperis 2009; Parker 2010), Ródos (Cuvelier and Mølgaard 2012; Galanos 2014), Simi (Cuvelier and Mølgaard 2012; Sotiris 2014), Spetses (Sotiris 2014), Tilos (Olivier 1993; Cuvelier and Mølgaard 2012 and Vido (Mathew 1898).

Figure 3. *Muschampia proto* from Šumet near Golubov kamen. Photo by Toni Koren.

Bulgaria

There is only a single record from Bulgaria (Abadjiev 2001), based on a single male specimen. According to Kolev (2002) this record is doubtful and requires confirmation.

Romania

While Romania is often cited as a country in which this species occurs, no reliable records could be found in the literature. Also, it is not listed in the appendix of the new checklist of butterflies of Europe (Wiemers et al. 2018) nor in the recent distribution overview of Hesperiidae in the country (Costache et al. 2019).

Conservation status

In general, the distribution of *M. proto* in the Balkan Peninsula is well established and the limits of its distribution are well known. Additional records are to be expected, especially from Montenegro and Albania, in the future as more parts of those countries will be surveyed. For Bosnia & Herzegovina it would be important to map the distribution of *P. fruticosa* and accordingly search for the presence of *M. proto*.

While the distribution of the species is well known, there is a surprising lack of data across the whole distributional range regarding its biology and ecology. According to Settele et al. (2008), *M. proto* occurs on dry, flower-rich grasslands, in open shrublands, and on rocky ground with sparse vegetation on which its larval foodplants are usually abundant. This is also the case in our study

area in which the species was found exclusively nearby *P. fruticosa* bushes. The skippers were never very abundant and usually only one or several specimens could be observed per locality. In general, we concluded that the best way to confirm the species' presence in an area is to search for the hostplant and visit the locality on several occasions. This was done in localities where we recorded *P. fruticosa* bushes, both in Croatia and Bosnia & Herzegovina.

As with other Hesperiidae, the males seem to be patrolling the habitat patches, usually along the paths or road verges. When resting, they usually choose to land on dry grasses or even bushes up to two metres in elevation. They are not difficult to spot, but can be easily mistaken for other Hesperiidae species which inhabit the same area and exhibit similar behaviour (e.g., *Carcharodus orientalis* Reverdin, 1913 or *Spialia orbifer* (Hübner, 1823)). As in other parts of the Balkans, *M. proto* can be observed from late spring until autumn due to prolonged emergence from the pupa.

While being rare and local in most of Europe, it seems that the species is not protected nor has any conservation status in most countries. According to the Climate Risk Atlas of European Butterflies (Settele et al. 2008), *M. proto* has an extremely high climate change risk (HHHR). This means that more than 95% of the grids with currently suitable climate may no longer be suitable in 2080 under at least one climatic scenario (Settele et al. 2008). According to the IUCN Red List Category at the Mediterranean level it is considered to be a Least concern (LC) species (Numa et al. 2016). In the Red book of butterflies of Croatia (Šašić et al. 2015) it is not even categorized. This is especially troubling since it appears that the species is confined to a very small area of approximately 15 km^2, taking into account the areas in both Croatia and Bosnia & Herzegovina.

Furthermore, the population in the study region represents the northernmost population in the Balkan Peninsula, with the closest populations approximately 30 km away in Montenegro. In the intermediary area south of Dubrovnik to the border with Montenegro, neither *P. fruticosa* no *M. proto* have been recorded so far.

Based on new observations, the status of this species in Croatia should be modified to vulnerable (VU) under IUCN criteria (IUCN 2001) V2 – area of occupancy smaller than 20 km^2, with the whole area being subject to the effects of human activities. This status is also supported by the fact that in Croatia its hostplant, *P. fruticosa* is characterised as near threatened (NT).

Only a single locality for this species is known from Bosnia & Herzegovina and due to the fact that *P. fructicosa* is very rare, it should be included in future Red lists and also listed as vulnerable (VU) under IUCN criteria V2 (IUCN 2001).

The main threat to the species' survival in the area is that its hostplant is growing mostly on road edges and the edges of urban areas. Such habitats are most strongly influenced by urbanisation, and some of the localities could disappear in the near future. It should also be taken into consideration that our observations show that *P. fruticosa* is present mostly in disturbed and anthropogenic habitats so it is possible that this facilitates the spreading of this species.

Local species with restricted geographic distribution and presumably small populations are much more vulnerable to extinction than the more widespread species (Sodhi and Ehrlich 2010), so actions to protect its habitat should be undertaken.

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